REMARKS

SECTION 112 REJECTIONS

Claim 1 was rejected under 35 U.S.C. §112 second paragraph as being indefinite because it was asserted that it was unclear how the scaling parameter for the random component was determined. With the present amendment, claim 1 has been amended to indicate that the scaling parameter for the random component is fixed such that it is the same for all frames and such that it is less than 1. With this amendment, claim 1 is definite as are claims 2, 3 and 5-12, which depend therefrom.

SECTION 103 REJECTIONS

Claims 1-3, 5, 6, 11, 12, 13, 15, 16, 20, 21, 23 and 24 were rejected under 35 U.S.C. §103(a) as being unpatentable over Laroche et al. ("HNM: A Simple, Efficient Harmonic and Noise Model for Speech" 1993, hereinafter Laroche) in view of Rao Gadde et al. (U.S. Patent 7,120,580, hereinafter Rao Gadde) in view of Gao (U.S. Publication 2002/0035470). Claims 7-10, 17 and 25 were rejected under 35 U.S.C. §103(a) as being unpatentable over Laroche in view of Rao Gadde in view of Gao and further in view of Seltzer (CMU Speech Group 1999).

CLAIMS 1-3 AND 5-12

Claim 1 provides a method of identifying an estimate for a noise-reduced value representing a portion of a noise-reduced speech signal. The method includes decomposing each frame of a noisy speech signal into a harmonic component for the frame and a random component for the frame. For each frame, a separate scaling parameter is determine for at least the harmonic component, wherein determining a scaling parameter for each frame of a harmonic component comprises determining a ratio of an energy of the harmonic component in the frame without the random component of the frame to an energy of the frame of the noisy speech signal. For each frame, the harmonic component of the frame is multiplied by the scaling parameter of the frame for the harmonic component to form a scaled harmonic component for the frame. For

each frame, the random component of the frame is multiplied by a fixed scaling parameter for the random component that is the same for all frames and that is less than 1. This forms a scaled random component for the frame. For each frame, the scaled harmonic component for the frame is summed with the scaled random component for the frame to form the noise-reduced value representing a frame of a noise-reduced speech signal wherein the frame of the noise-reduced speech signal has reduced noise relative to the frame of the noisy speech signal.

The amendments to claim 1 find support in the specification on page 15, line 26 to page 18, line 1.

As amended, claim 1 is not shown or suggested in the combination of cited art. In particular, none of the references show or suggest determining a scaling parameter for each frame of a harmonic component by determining the ratio of an energy of the harmonic component in the frame without the random component of the frame to an energy of the frame of the noisy speech signal. In addition, none of the cited references show or suggest determining a scaling parameter for a harmonic component that changes as the ratio of the energy of the harmonic component to the energy of the noisy speech signal changes while using a fixed scaling parameter for a random component.

In the Office Action, it was asserted that Gao shows the formation of a scaling parameter for a harmonic component by determining the ratio of an energy of the harmonic component with an energy of a noisy speech signal because it shows a gain factor that is computed as 1-NSR, where NSR is interpreted to be a noise-to-speech ratio. In particular, it was asserted in the Office Action that 1-NSR is equal to 1-noise/(signal(noise+speech)) and that this reduces to speech/(noise+speech). Applicants respectfully dispute this assertion.

In Gao, NSR is defined as having a value of 1 when only background noise is detected in a frame and otherwise being equal to the square root of the background noise energy divided by the signal energy in the frame. Because NSR is being defined as the square root of the background noise to the energy of a noisy speech signal in a frame, the formula provided in the Office Action is not correct. Instead, the formula should be: $1-\sqrt{Noise\,/\,NoisySpeech}$. Further, because of the square root, the reduction provided in the Office Action does not apply. As such,

the NSR definition provided by Gao cannot be reduced to form the ratio of speech/noise+speech provided in the Office Action.

Further, Gao does not provide a means for determining a scaling parameter that would be equivalent to the scaling parameter computed in claim 1. In particular, in Gao, the only technique described for identifying the amount of background noise is to identify frames that do not include speech and to identify the background noise in those frames. The background noise is then propagated forward to additional frames to compute the noise-to-signal ratio. However, since background noise is not static, but varies, the background noise actually present in a later frame will not be the same as the background noise determined in a prior frame. Because of this, the gain factor computed in Gao, which relies on noise from a previous frame, would not be equivalent to the scaling parameter computed in claim 1 which utilizes the harmonic component of the current frame and the energy of the current frame of the noisy speech signal to compute the scaling parameter instead of relying on background noise from a previous frame.

As noted in the present specification, relying on background noise from a previous frame creates errors and does not remove as much noise as may be desired. For example, if the environment is relatively quiet when no speech is present, the background noise will be measured as being quite low. However, if the speaker begins to speak and at the same time the noise increases, the Gao system will not detect the noise increase and will continue to apply the old noise when determining the noise-to-signal ratio. This will cause the noise-to-signal ratio computed by Gao to be much lower than it actually is. However, with the invention of claim 1, the scaling parameter will better track the actual ratio of the energy of the harmonic component within the current frame to the energy of the noisy speech signal within the current frame since it does not rely on a past noise-level measure.

In addition, the combination of cited references does not show a scaling parameter for a harmonic component that is determined from a ratio of an energy of a harmonic component to the energy of a noisy speech signal used in combination with a fixed scaling parameter for a random component.

In Rao Gadde, the scaling parameter for the noise model is one minus the scaling parameter for the clean speech model. As such, the scaling parameter in Rao Gadde for the noise model is not fixed but instead appears to vary with the scaling parameter for the clean speech model. Further, those skilled in the art would not replace the scaling parameter in Rao Gadde with a fixed scaling parameter for the noise model. Under Rao Gadde, a noisy speech model M' is being constructed from a clean speech model M and a noise model N. This combination appears to be based on a signal-to-noise ratio of a noisy input speech signal. Thus, in instances where there is a high signal-to-noise ratio, the noisy speech model will be taken mostly from the clean speech model. In those instances with a low signal-to-noise ratio, the noisy speech model will be taken primarily from the noise model. If a fixed scaling value is used instead of using a scaling value that is based on the signal-to-noise ratio, then the noisy speech model will include too much noise when the signal-to-noise ratio is high and too little noise when the signal-to-noise ratio is low. This will cause the noisy speech model M' to contain a different amount of noise than the input signal and as such degrade recognition performance. As such, those skilled in the art would not replace the scaling parameter in Rao Gadde with a fixed scaling parameter for the noise model.

Since the prior art does not show determining a scaling parameter for a harmonic component that is determined for each frame based on the energy of the harmonic component in the frame and the energy of the noisy speech signal in the frame or using a scaling parameter for a harmonic component that is determined for each frame while using a fixed scaling parameter for a random component, the combination of the cited art does not show or suggest the invention of claim 1 or claims 2, 3 and 5-12 which depend therefrom.

<u>CLAIMS 13, 15-17, 20-21 and 23-25</u>

Independent claim 13 provides a computer-readable storage medium having computer-executable instructions for performing a series of steps. Those steps include identifying a harmonic component and a random component in a noisy speech signal, wherein identifying the harmonic component comprises modeling the harmonic component as a sum of

harmonic sinusoids, each sinusoid having an amplitude parameter. A weighted sum is formed to produce a noise-reduced value representing a noise-reduced speech signal that has reduced noise compared to the noisy speech signal. The weighted sum is formed by multiplying the harmonic component by a scaling value for the harmonic component to form a scaled harmonic component, multiplying the random component by a scaling value for the random component to form a scaled random component, and adding the scaled harmonic component to the scaled random component to form the noise reduced value. The scaling value for the harmonic component is different than the scaling value for the random component. In addition, the scaling value for the harmonic component is separately determined for each frame of the noisy speech signal and the scaling value for the random component is fixed for all frames of the noisy speech signal so that the same scaling parameter for the random component is used at each frame of the noisy speech signal.

In the amendment to claim 13, the limitations of claims 21 and 23 have been added to claim 13. As amended, claim 13 is not shown or suggested in the combination of cited art. In particular, none of the cited references show or suggest a scaling value for a harmonic component that is separately determined for each frame of a noisy speech signal together with a scaling value for a random component that is fixed for all frames of the noisy speech signal.

In the Office Action, claim 23 was rejected by citing Rao Gadde. In particular, the scaling parameters for the clean speech model and noise model were cited as the scaling values for the harmonic component and the random component. However, as pointed out in the Office Action itself, the scaling parameter for the noise model in Rao Gadde is "separately determined for each frame in the speech signal." Thus, the scaling parameter for the noise model in Rao Gadde is not fixed for all frames of the noisy speech signal, but instead must be separately determined at each frame. This is substantially different from the invention of claim 13, where the scaling value for the random component is fixed for all of the frames in the noisy speech signal so that the same scaling parameter is used on each frame of the noisy speech signal for the random component. Further, those skilled in the art would not modify Rao Gadde to use a fixed scaling parameter for the noise model since this would cause either too much noise or too little

noise to be added to the noisy speech model thereby making the noisy speech model a poor model for the input noisy speech signal.

Since the combination of cited art does not show the combination of a scaling value for a harmonic component that is separately determined for each frame of a noisy speech signal with a scaling value for a random component that is fixed for all frames of the noisy speech signal, the combination does not show or suggest the invention of claim 13 or claims 15-17, 20, 24 and 25.

CONCLUSION

In light of the above remarks, claims 1-3, 5-13, 15-17, 20, 24 and 25 are in form for allowance. Reconsideration and allowance of the claims is respectfully requested.

The Director is authorized to charge any fee deficiency required by this paper or credit any overpayment to Deposit Account No. 23-1123.

Respectfully submitted,

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